

## The importance of herbarium records in documenting the occurrence and changing distribution of the adventive moss species *Pseudoscleropodium purum* in Victoria

Josephine Milne and Helen Jolley

National Herbarium of Victoria, Royal Botanic Gardens Melbourne, Birdwood Ave, South Yarra 3141

### Abstract

Herbarium records are essential, verifiable records of a species at a particular place and time. Very few cryptogams are listed as environmental weeds. Over time, the distribution of the adventive moss *Pseudoscleropodium purum* in Victoria has expanded, and there is now evidence of it occurring in native vegetation. The capacity for growing a new plant from fragments requires care in managing disturbed, grassy areas where this moss grows. (*The Victorian Naturalist* 127 (4) 2010, 146–150)

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Herbarium specimens are a permanent record confirming the occurrence of a species at a particular locality and time. The label data associated with the specimens also provide a verifiable and invaluable source of information such as distribution, ecological preferences and associated species. Once databased, the information accompanying the specimens becomes readily accessible. The occurrence and distribution of a particular weed species is often based on herbarium specimens and anecdotal observations. While anecdotal observations are valuable contributions, they are usually not represented by a voucher and often lack associated habitat and substrate details.

For higher plants that are known weeds, there is usually extensive knowledge about their taxonomy, biology and ecology which informs monitoring and management programs. In Victoria alone there are c. 1434 listed higher plant weed species, which includes native Victorian and Australian plants (Stajsic pers. comm. 2010). In contrast, there are very few species of cryptogams (mosses, liverworts, lichens and fungi) listed as weeds. To date in Australia, two mosses are considered weedy species, *Rhytidiadelphus squarrosus* (Hedw.) Warnst. recorded from Tasmania (Dalton 1997) and *Pseudoscleropodium purum* (Hedw.) M.Fleisch. recorded from south-eastern Australia (Scott and Stone 1976; Meagher and Fuhrer 2003). The liverwort *Marchantia polymorpha* introduced from Europe has long been recognised as a weedy species in nurseries, greenhouses and home gardens (Scott 1985; Meagher and Fuhrer 2003).

More recently, there has been increased documentation of the fungus *Amanita muscaria* introduced with *Pinus radiata*, escaping into native forests of Victoria, New South Wales and Tasmania (Fuhrer and Robinson 1992; Dunk 2002; Lebel pers. comm. 2010).

The precise original range of the European moss *Pseudoscleropodium purum* (Hedw.) M.Fleisch. is uncertain. It now occurs throughout Europe, the United Kingdom, a few localities in the USA (Miller and Trigoboff 2001), Chile (Allen and Crosby 1987), New Zealand (Lewinsky and Bartlett 1982) and Australia (Scott and Stone 1976). It is widespread in both natural and disturbed habitats.

In Australia *P. purum* is currently recorded from New South Wales, Victoria and Tasmania (Fig. 1). The distribution map is based on specimen data from the Australia's Virtual Herbarium which includes vouchers held at MEL, NSW and HO. Anecdotal observations or data from specimens held in University herbaria are not included in the distribution map (Fuhrer 2004; Adair *et al.* 2008; Manningham City Council 2008; Downing pers. comm 2010; Gibson pers. comm. 2010). Unfortunately, though containing valuable records, in many cases the University collections are basically inaccessible, being 'unlisted' (as many are not registered herbaria) and generally not databased. In Victoria, there are a number of disjunct records which extend from Portland in western Victoria, to the Tarra Valley in East Gippsland, and Wendouree, north-west of Melbourne. Most records are from Metropolitan Melbourne, particularly the eastern



Fig. 1. Distribution of *Pseudoscleropodium purum* in Australia. (specimen data reproduced from Australia's Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.).

bayside, eastern and north eastern suburbs and the Central Highlands (Fig. 2). An increase in documented records of *P. purum* over the last decade suggests that it is spreading in these latter localities (Fig. 1), although these vouchers may represent a collecting bias (Table 1).

Herbarium records indicate that *P. purum* was first recorded in Victoria in 1946; exactly when and how it was introduced is unknown. The introduction of this species outside Europe has been attributed to its use as packaging material for nursery stock (Lawton 1960; Dickson 1967; Schofield and Crum 1972; Miller and Trigoboff 2001). Given that one of the earliest records is from soil beneath conifers, there is the possibility that this species was introduced into Victoria in a similar manner.

Where *P. purum* has been documented outside its natural range, it occurs in disturbed areas (Lewinsky & Bartlett 1982, Miller & Trigoboff 2001, Downing pers. comm. 2010). Collecting details from Victorian herbarium records indicate that *P. purum* occurs predominantly where there has been disturbance e.g. edges of walking tracks in reserves and parks, in picnic areas, along roadsides and roadside embankments. In Sydney, it is often found where there are increased levels of nutrients (e.g. leachate from concrete and bitumen), moisture (e.g. from storm water drains), and permeable substrates (e.g. soil, sand, sandstone) covered with hard surfaces such as concrete. *Pseudoscleropodium purum* does particularly well where there

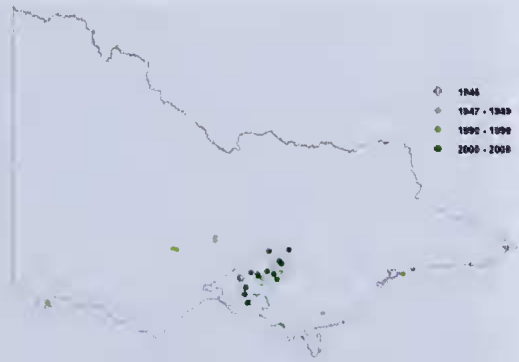


Fig. 2. Distribution of *Pseudoscleropodium purum* in Victoria (specimen data reproduced from Australia's Virtual Herbarium with permission of the Council of Heads of Australasian Herbaria Inc.).

is added calcium carbonate, either on natural occurring limestones, or paddocks that have been fertilised, or close to drains, concrete paths, roads and gutters (Downing pers. comm. 2010). More recent collections from Victoria are confirming what has been suspected for some time, that the species is invading native vegetation (Table 1).

*Pseudoscleropodium purum* belongs to the family Brachytheciaceae, which is characterised by pleurocarpous mosses. This moss forms quite extensive green to yellow mats (Schofield 2008), often with robust stems weaving through grass on roadside verges or in lawns (Fig. 3). Stems are julaceous, and easily recognised by their regularly pinnately branched habit. Leaves are concave and the leaf apex is reflexed (Schofield 2008). This species is dioicous (male and female reproductive structures occur on separate plants) and outside its natural range there are few records of this species producing sporophytes. In the southern hemisphere, the only known record of sporophytes is from New Zealand (Lewinsky and Bartlett 1982), where they are still considered extremely rare (Fife pers. comm. 2010). Therefore, this moss must reproduce through another mechanism. Sporophytes are not known from Australia, and *P. purum* does not produce specialised asexual propagules (i.e. gemmae, tubers, flagelliferous branches), therefore the spread of this moss has been attributed to its ability to readily establish new populations from fragments (totipotency, the ability of any fragment to grow into a new plant (Malcolm and Malcolm 2006; Lewinsky and Bartlett 1982, Miller



Fig. 3. *Pseudoscleropodium purum* growing in a disturbed area (photo courtesy of M Gibson).

and Trigoboff 2001). Mowing of grassed areas in reserves and road embankments where this species is often common produces fragments which can then be easily dispersed by wind, humans and machinery.

Herbarium records to date support the description of this species as an adventive weed with the potential for it to invade more areas of native vegetation. In the USA this species is spreading rapidly and is considered a 'troublesome lawn weed' (Rohrer and Kirkpatrick 1985). This moss could become a serious environmental weed in Australia as the tiny fragments are readily dispersed through human activity and quite possibly by wind. A greater awareness of adventive bryophytes is slowly developing with *P. purum* being included in plant inventories (Adair *et al.* 2008, Manningham City Council 2008). This awareness is also influencing collecting effort as is apparent from the increased number of vouchers accessioned at MEL in the last decade. Increasingly government agencies and consultants request information on the distribution of weed taxa from State and Territory herbaria, therefore to monitor the spread of this and other potential cryptogamic adventive species it is crucial that records are supported by herbarium vouchers.

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### References

- Adair R, Cheal D and White M (2008) Advisory list of environmental weeds in coastal plains and healthy forest bioregions of Victoria. <http://www.dse.vic.gov.au/>, accessed 14 Apr 2010.
- Allen BH and Crosby MR (1987) *Pseudoscleropodium purum* re-established in South America. *Journal of Bryology* 14, 523-525.
- Dalton P (1997) *Rhytidiadelphus squarrosus* – an adventive species in western Tasmania. *Australasian Bryological Newsletter* 36, 4-6.
- Dickson JH (1967) *Pseudoscleropodium purum* (Limpr.) Fleisch. on St Helena and its arrival on Tristan da Cunha. *The Bryologist* 70, 267-268.
- Dunk CW (2002) The ectomycorrhizae of *Nothofagus cunninghamii* (Hook.) Oerst. in Noojee State Forest, Victoria, and evidence of host shifting by the introduced fungus *Amanita muscaria* (L.Fr.) Pers. – identification, host determination, and characterisation of the new association. (Unpublished, Honors Thesis, LaTrobe University).
- Fuhrer BA (2004) A Miscreant Moss! *FriendsNET* 48, 2.
- Fuhrer BA and Robinson R (1992) Rainforest fungi of Tasmania and south-east Australia. (CSIRO: Collingwood, Victoria).
- Lawton E (1960) *Pseudoscleropodium purum* in the Pacific Northwest. *The Bryologist* 63, 235-237.
- Lewinsky J and Bartlett J (1982) *Pseudoscleropodium purum* (Hedw.) Fleisch. in New Zealand. *Lindbergia* 8, 177-180.
- Malcolm B and Malcolm N (2006) *Mosses and other bryophytes, an illustrated glossary*, 2 ed, (Micro-Optics Press: New Zealand)

- Manningham City Council (2008) Mullum Mullum Creek Linear Park Stage 3 Management Plan. [http://www.bv.com.au/file/Stage3\\_DraftPlantJun08.pdf](http://www.bv.com.au/file/Stage3_DraftPlantJun08.pdf), accessed 14 April 2010.
- Meagher D and Fuhrer BF (2003) *A Field Guide to the mosses and allied plants of Southern Australia*. Flora of Australia Supplementary Series No. 20. (Australian Biological Resources Study: Canberra)
- Miller NG and Trigoboff N (2001) A European feather moss, *Pseudoscleropodium purum*, naturalized widely in New York state cemeteries. *The Bryologist* **104**, 98-103.
- Rohrer JR and Kirkpatrick HE (1985) *Pseudoscleropodium* discovered in the Great Lakes Region. *The Bryologist* **88**, 24-25.
- Schofield WB (2008) *Pseudoscleropodium* – Brachytheciaceae, In Bryophyte Flora of North America Provisional Publication Vol. 2, <http://www.mobot.org/plantscience/BFNA/bfnamenu.htm>, accessed 25 March 2010.
- Schofield WB and Crum HA (1972) Disjunctions in Bryophytes. *Annals of the Missouri Botanical Garden* **59**, 174-202.
- Scott G (1985) *Southern Australian Liverworts*. Australian Flora and Fauna Series No. 2, (AGPS: Canberra)
- Scott GAM and Stone IG (1976) *The Mosses of Southern Australia*. (Academic Press: London)

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**Table 1.** Year of collection, habitat and associated notes from vouchers of *Pseudoscleropodium purum* at MEL.

Date of collection	Bioregion	Habitat
1946	Gippsland Plain	Earliest collection yet of this introduced species.
1956	Midlands	In dense shade, on ground under planted conifers.
	Vic Volcanic Plain	Forming large patches on the ground. Sometimes with <i>Hypnum cupressiforme</i> . Abundant, (spreading.)
1960s	Gippsland Plain	
	Gippsland Highlands	Forming large loose masses on sandy soil of paddock, climbing up into near tea-tree scrub.
1990s	Eastern Highlands	Luxuriant along a roadside bank between creek and buildings.
	Eastern Highlands	Abundant.
	Eastern Highlands/ Gippsland Plain	In grass near dam. Abundant in the area.
	Midlands	In dry sclerophyll forest dominated by <i>Eucalyptus obliqua</i> , <i>E. radiata</i> and <i>E. dives</i> , on Ordovician sediments with quartz. Growing among leaf litter on a south facing earthbank in an old gold mining shaft. Forming extensive cover in areas.
	Vic. Volcanic Plain	In degraded weedy woodland with a mixture of planted and remnant vegetation. Woodland dominated by <i>Eucalyptus camaldulensis</i> , <i>E. viminalis</i> and <i>Acacia melanoxylon</i> . Geology is Quaternary Newer basaltic. Growing on the ground among predominantly exotic grass and leaf litter. Associated with <i>Hypnum cupressiforme</i> .
2000	Eastern Highlands	Temperate rain forest margin. Terrestrial on earth wall along parking lot.
2001	Eastern Highlands	Grassy area of picnic ground. Terrestrial.
2005	Gippsland Plain	In remnant, dense heathland on grey-white sandy soil. Terricolous, among leaf litter. Forming a large, dense mat 1 x 1 m. Only one patch seen. Associated spp: <i>Bossiaea cinerea</i> , <i>Cassytha pubescens</i> (abundant), <i>Correa reflexa</i> , <i>Dianella brevicaulis</i> , <i>Hibbertia acicularis</i> , <i>H. sericea</i> , <i>Lepidosperma concavum</i> , <i>Opercularia varia</i> , <i>Ricinocarpos pinifolius</i> , <i>Senecio glomeratus</i> and <i>Thelymitra brevifolia</i> .
	Eastern Highlands	In swampy <i>Eucalyptus camphora</i> woodland. Terricolous, the infestation is several square metres in area.
2006	Gippsland Plain	Growing on the ground among moist grass (mainly <i>Ehrharta erecta</i> ), in disturbed and weedy <i>Banksia integrifolia</i> woodland. Associated species: <i>Acacia longifolia</i> subsp. <i>sophorae</i> , <i>Delairea odorata</i> , <i>Leptospermum laevigatum</i> and <i>Rhagodia candolleana</i> . Mat forming. Covering an area 1 x 1 m.

Table 1 contd.

Date of	Bioregion	Habitat
2006	Eastern Highlands	Terricolous, amongst moist grass beside walking track, in tall open forest dominated by <i>Eucalyptus cypellocarpa</i> and <i>E. viminalis</i> subsp. <i>viminalis</i> , with understorey of <i>Acacia dealbata</i> and <i>A. obliquenervia</i> . Forming extensive mats, 2 x 2 m in size.
	Eastern Highlands	Terricolous, amongst moist grass beside the road, in tall forest dominated by <i>Eucalyptus</i> aff <i>camphora</i> and <i>E. cypellocarpa</i> , with an understorey of <i>Acacia dealbata</i> , <i>Cassinia aculeata</i> , <i>Lepidosperma laterale</i> var. <i>majus</i> and <i>Melaleuca squarrosa</i> . Forming extensive, dense mats. Common beside road.
	Gippsland Plain	Terricolous, in disturbed, weedy area between the former <i>Ludwigia</i> pond and the bike path. Growing among * <i>Dactylis glomerata</i> . Associated with <i>Eurhynchium praelongum</i> . Forming extensive mat. Common.
	Eastern Highlands	Terricolous, beside the road in a sparsely grassed site, in dry open heathy woodland dominated by <i>Eucalyptus goniocalyx</i> and <i>E. obliqua</i> . Associated with: <i>Acacia leprosa</i> , <i>A. myrtifolia</i> , * <i>Agrostis capillaris</i> , <i>Cassinia aculeata</i> , <i>Gahnia radula</i> , <i>Gonocarpus etragynys</i> , <i>Hakea ulicina</i> , <i>Helichrysum scorpioides</i> , <i>Pimelea flava</i> , <i>Thuidiopsis furfurosa</i> , <i>Themeda triandra</i> and <i>Viola hederacea</i> . Forming extensive, dense mats. This patch 6 x 2 m.
	Gippsland Plain	Disturbed <i>Melaleuca ericifolia</i> shrubland. Growing beneath tree canopy. Mat forming moss. Yellowish colouration. Common.
	Gippsland Plain	Terricolous, on grey-white sand in relatively species diverse coastal heathland. Growing in partial shade adjacent to <i>Leptospermum laevigatum</i> . Associated species: <i>Bossiaea cinerea</i> , <i>Dianella brevicaulis</i> , <i>Leptospermum continentale</i> and <i>Pteridium esculentum</i> . Forming a dense mat. Only one patch seen, 1.5 x 1 m.
2007	Gippsland Plain	Growing beside walking track in disturbed <i>Eucalyptus radiata</i> , <i>E. obliqua</i> and <i>E. viminalis</i> woodland. Associated species: <i>Acacia mearnsii</i> , <i>A. melanoxylon</i> , <i>A. verticillata</i> , <i>Pteridium esculentum</i> , <i>Gahnia radula</i> , <i>Senecio glomeratus</i> , * <i>Asparagus asparagoides</i> , * <i>Oxalis incarnate</i> , alien grasses, <i>Eurhynchium praelongum</i> (common). Terricolous, among moist grass and litter. Forming extensive, light-green mats. Common along the walking track.
2008	Eastern Highlands	In slashed roadside, with adjacent <i>Eucalyptus obliqua</i> and <i>E. radiata</i> dominated forest. Terricolous, among grass. Forming extensive mats. Common.
	Eastern Highlands	Growing in moist grass, beside road, at the edge of tall open forest dominated by <i>Eucalyptus nitens</i> and <i>E. regnans</i> . Terricolous, forming extensive carpets. Common at site of collection.
	Eastern Highlands	Degraded, weedy roadside remnant, with an overstorey of <i>Eucalyptus cypellocarpa</i> . On the ground, among grass and litter. Forming a patch ca. 1 metre across.

\* Associated species introduced either to the state or locality.



Caterpillars on Dandelion and Cat's Ear flowers. Photos by Virgil Hubregtse; see article on page 155.